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Three Years of COVID-19-related School Restrictions and Mental Health of Children and Adolescents in Japan¹

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Abstract

During the three years of the COVID-19 pandemic, Japanese children lived with strict mitigation measures at school, such as eating school lunches silently and wearing masks during physical exercise classes, even after those mitigation measures have been relaxed worldwide. Excursions and other school events were frequently cancelled, especially in 2020 and 2021. This study conducts a retrospective survey on school experiences to understand how the strict mitigation measures were related to children's mental health and well-being. Results revealed school excursion cancellation to be associated with a higher risk of developing depressive symptoms (odds ratio [OR] 1.543 [95% confidence interval {CI} 1.109-2.148]), and high cancellation rate of other school events to be associated with dissatisfaction in school experience (OR 1.650 [95% CI 1.222-2.228]). In the subsample analysis, we found that girls and children with no extracurricular activities tended to exhibit depressive symptoms due to the cancellation of school excursions. Overall, our study demonstrated that persistent strict mitigation measures at schools might be a key factor in understanding children's mental health and psychological well-being during a long-lasting pandemic.

Keywords: Children, Covid-19, Mental Health, Non-Pharmaceutical Intervention.

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1. Introduction

Coronavirus disease 2019 (COVID-19) spread rapidly worldwide in early 2020. Non-pharmaceutical interventions, such as school closures and lockdowns, were implemented globally to contain the spread of COVID-19. Although children and adolescents were at a low risk of severe illness from COVID-19 itself^{1,2}, they had to cooperate with the various mitigation measures. While the measures were likely important in containing the spread of COVID-19, they might have potentially disrupted the mental health of children and adolescents³⁻⁶.

In fact, according to a meta-analysis covering the results obtained in the COVID-19 pandemic, about 20 percent of youth globally are experiencing clinically elevated depression symptoms and the prevalence is higher in studies collected later in the pandemic^{7,8}. Several studies also found well-being of children at school deteriorated during the pandemic^{9,10}.

In Japan, strict mitigation measures continued even after the fall of 2021, when the epidemic of the Delta variant ended, and the first two doses of vaccines had been administered to the majority of the adult population. By this time, many developed countries had relaxed their policies on COVID-19, as vaccines had become sufficiently widespread. When the Omicron variant—featuring a lower rate of severe cases than the previous variants—became dominant in early 2022, most countries relaxed their policies even further. However, the Japanese government did not alter its COVID-19 policies much, and from January to March 2022, when infection waves with the Omicron variant swept across the country, many prefectures and subregions of Japan still enforced restaurant hour restrictions and urged citizens to comply with various mitigation measures¹¹. The policies permeated into schools as well, and many school events were cancelled throughout the country. According to a national survey, the proportion of public high schools that conducted school excursions, was only 31.3% in FY (fiscal year) 2020 and 76.1% in FY2021¹² compared to almost 100% in 2018.

Extracurricular school events are generally regarded as an integral part of education in Japan. They likely foster various virtues such as solidarity, teamwork, and responsibility¹³. Students themselves value these events. In normal times before the pandemic, for example, one qualitative study reveals that positive feelings toward school events among students were higher than "study" and "recess" and were rated about the same as "hobbies" and "family"¹⁴. Thus, the cancellation of such events could have a significant negative impact on children's satisfaction and mental health, which is often ignored in the debate over pandemic-related policies.

In daily school life, as of March 2023, many Japanese schools also required students to wear masks in music classes in which they sang together, as shown in SI Appendix, Figure SII-(a). Students enjoyed their school lunches in a lively atmosphere before the pandemic, but conversations during school lunch time were forbidden to reduce the risk of droplet transmission. Some schools used acrylic boards to separate the tables as a protection against droplet infection during lunch. This style of school lunch is referred to as silent lunch or *mokusyoku* in Japanese^{15,16}—as shown in SI Appendix, Figure SII-(b). For details on the mitigation measures in schools in Japan, please refer to the work by Shobako (2022)¹⁵. As a result of these measures, 86% of the children reported that they have friends whose faces they have never seen due to masks¹⁷. Although the cumulative number of deaths under the age of 20 years, due to COVID-19, over the past three years was limited in Japan (62 children¹⁸ in a population of over 120 million), balancing the advantages and disadvantages of COVID-19 mitigation measures in schools should have been at the forefront of policy debate.

Despite the need to understand the impact of school restrictions during the COVID-19 pandemic on children, most studies till date have mainly focused on the impact of *school closures* on children's well-being^{3,5,19,20} and academic achievement^{21,22}, and not much on how the continuation of strict mitigation measures after school reopening have affected them. In Japan, schools were closed nationwide only during the initial stages of the pandemic, from early March to the end of May²³ and 97.7% of the schools reopened by June 1²⁴. However, for the next three years, school life was far from normal. Most school events were cancelled or scaled down even if they were held. It should be also noted that, while several studies have reported severe mental health deterioration among children and adolescents during the COVID-19 pandemic in Japan, including an increase in eating disorder²⁵ and suicide rate^{26–28}, no studies have explored the association between persistent mitigation measures at school and children's mental health. Exploration of this association is relevant from a policy perspective because our knowledge on the cost of mitigation measures at school is quite limited, compared with that on the benefits in terms of containment of infectious spread^{29,30}.

We, therefore, conducted a retrospective online survey in children in their final years of school to explore the association between mitigation measures at school and children's mental health and well-being during the pandemic. The survey was conducted during March 15–20, 2023, when the graduation ceremony was held across schools in Japan, by hiring one of the largest survey companies in Japan. A total of 1,795 parents submitted complete data. We asked whether school events, such as school excursions and sports days, were implemented or cancelled in 2020, 2021, and 2022. As outcome

variables, we asked about the satisfaction level regarding the school experience and friendship as of March 2023. We also asked about their tendency toward depression using the Japanese version of the WHO-5 well-being index³¹. We conducted statistical analysis using a multivariate logistic regression model that controlled for prefecture-fixed effects.

2. Methods

2.1 Study design and participants

This quantitative, retrospective, cross-sectional study included children and adolescent, in their final year of school, with their parents. Since children in Japan generally attend elementary school between the ages of 6 and 12, junior high school between 13 and 15, and high school between 16 and 18 years. We retrospectively asked 6th graders in elementary school, 3rd graders in junior high school, and 3rd graders in high school about their experiences in school over the past three years. The survey was conducted between March 15 and March 20, immediately after graduation ceremonies were held in each school. To conduct the survey, we hired one of the largest internet research firms in Japan, namely Cross Marketing, Inc (Tokyo, Japan). Parents (not children) were registered as respondents with the survey company.

We asked the parents to complete the survey with their children because some children are likely to have difficulty completing an internet survey by themselves. This survey design is employed in other studies that explore children's mental health during the pandemic³². This design comes with a caveat, which we will discuss later in the paper.

In the screening survey, we first asked about the grade level of the parent's oldest child, and if the grade was the final one of that school (6th year in elementary school, 3rd year in junior high school, or 3rd year in high school), the respondents proceeded to the main survey. The survey continued until there were 700 children in each grade, bringing the total number of respondents to 2,100. The survey was conducted in accordance with the Declaration of Helsinki. Samples were coded and analysis was performed with anonymized database. Informed consent for survey participation was obtained from each patient. This study was approved by the Ethics Committee of University of Tokyo (20-014). Data and related materials are available upon request to the authors. The supplementary information file is available online along with this article.

2.2 COVID-19 mitigation measures in school

One of the important aspects of mitigation measures in schools was the frequent

cancellation of school events. We asked the implementation status of 13 popular school events that included (1) field trips, (2) social studies tours, (3) school excursions, (4) school events involving overnight stays other than school excursions, (5) athletic meets and festivals, (6) marathons, (7) swimming competitions, (8) ball game competitions (basketball, volleyball, dodgeball, etc.), (9) athletic events other than the above, (10) cultural and school art festivals, (11) chorus singing contests, (12) calligraphy contests, and (13) arts and humanities events other than the above. Since children sometimes miss a school event anyways, or schools could cancel events for reasons unrelated to COVID-19, we explicitly asked our survey participants the reason behind an event not being implemented by including certain choices in the answer options given to them, namely (1) participated; (2) held but did not participate; (3) held before the COVID-19 pandemic but not that year; (4) neither held before the COVID-19 pandemic nor that year; (5) was not of eligible age (e.g., 4th-year elementary school student did not participate in the school excursion in FY2020). For each year from 2020 to 2022, we asked about the cancellation of 13 school events one by one. The total cancellation rate is calculated as the ratio of the total number of cancellations to the number of school events that would have been held from 2020 to 2022 in the absence of the pandemic (computed using 2019 as a “typical non-pandemic year”).

Since school excursions are special events for Japanese students, occurring only once during each school term, and typically lasting over several days, we created a binary variable that takes a value of 1 if the school excursion was canceled due to COVID-19, separating the cancellation status of other school events. The cancellation of other events was measured by the total cancellation rate, which is the ratio of (3) to the sum of (1)–(3) for the 12 school events, except for school excursions. To gain an intuitive understanding of the results, a binary variable was created for children who experienced a cancellation rate above the median.

Next, we asked whether the school implemented silent lunches in March 2023. Since anecdotal evidence suggested that silent lunches would continue in many schools, even in 2023, we included this question to quantify the effects. Note that we did not investigate the status of mask-wearing in schools because mandatory mask wearing was first relaxed in April 2023, after our survey was completed.

2.3 Outcome measures

For the primary outcome, we used the Japanese version of WHO-5 index³¹ to measure depressive symptom. The index was calculated based on the answers to five questions on well-being and mental health. Each question was answered on a 6-point scale from 0 (very bad) to 5 (very good), and the total score ranged from 0 to 25, with 0 indicating the poorest mental health and 25 indicating the best mental health. Since a screening test for depression is recommended when the total score is less than 13 or when there is a 0 or 1 response to any of the five items, a binary variable was created with 1 for children who fit this criterion. While WHO-5 index is used to measure the mental health of the adult population in many studies, it is also validated for children and adolescents³³. It was noteworthy that although the survey was sent to the parents, the latter were requested to complete the survey with their children; therefore, the response results could be interpreted as a measure of their children's mental health.

Next, we asked about satisfaction levels with (a) overall school experience and (b) friendship to measure the school related well-being of children and adolescent, using a 5-point Likert scale. Based on these questions, we constructed two binary variables; one was “Satisfaction” that takes a value of 1 for “Very satisfied” and 0 for “Not satisfied,” and another was “Dissatisfaction” that takes a value of 1 for “Not satisfied at all.”

2.4 Children’s characteristics

In addition to the basic characteristics, such as age, sex, and prefecture of residence, we asked how the respondents performed the subjective assessment of the effectiveness of five mitigation measures in school using the following points: (1) silent school lunch, (2) wearing masks at school, (3) cancellation of school trips, (4) cancellation of club activities, and (5) cancellation of school events. Respondents reported 0 if they thought each infection control measure was very effective, and 6 if it was not effective. By summing up the scores of the five items, we created a total score for the subjective assessment of the effectiveness of mitigation measures, which ranged from 0 (highest evaluation) to 30 (lowest evaluation). We create a binary variable that takes a value of 1 for respondents who report a total score above the median. The median score was 13 points. The distribution is shown in SI Appendix, Figure SI2.

Next, we asked whether each child participated in extracurricular activities (“*Bukatsu*” in Japanese), such as football club and brass band, because the quality of experience with these extracurricular activities could be associated with friendship in schools, and ultimately mental health and well-being³⁴.

2.5 Statistical analysis

We used a logistic regression model to explore the association between binary outcome variables and school mitigation measures. As covariates, we controlled for the age, sex, membership status in extracurricular activities, and subjective evaluation of the effectiveness of infection control measures in school.

In addition, the prefecture-fixed effects absorbed prefecture-level unobservable differences across the 47 prefectures, such as the extent of COVID-19 prevalence and the duration of school closure. The fixed effects absorbed most of the effects of mitigation measures implemented in places other than schools. Most importantly, the prefecture-fixed effects absorbed the cumulative effects of the state of emergency declaration—the Japanese version of lockdown^{11,35}—which was reported to be associated with mental health and well-being^{36,37}, since the state of emergency was implemented at the prefecture level. In addition, the direct effects of fear of infection³⁸ on mental health were also alleviated when we controlled for prefecture-fixed effects, since the variation in infection within prefectures was not as large, and was at least less than the variation across prefectures.

For statistical analysis, we excluded 218 children who attended schools in which excursions were not implemented even before the COVID-19 pandemic; 87 children were further excluded due to missing values on the cancellation status of other school events (e.g., they reported “(4) Not held before COVID-19 pandemic and not that year” for all events). Finally, 1,795 children were included in the statistical analysis. Data were analyzed using Stata version 15 (College Station, TX, USA). All tests were two-tailed, and p values < 0.05 were considered statistically significant.

3. Results

3.1 Descriptive statistics

Table 1 presents the descriptive statistics of the respondents. The total sample size was 1,795. Among them, 19.1% of children exhibited WHO-5 index scores below the clinical cut-off value, suggesting that one-fifth of the children included in our analysis exhibited depressive symptoms. The prevalence of depressive symptoms in our study is consistent with previous studies during the pandemic but is slightly higher than those reported before the pandemic. In our study, about one-fifth (19.1%) of children exhibited depressive symptoms, scoring WHO-5 index below the clinical cut-off value. The meta-analysis on

the prevalence of depression during the COVID-19 pandemic reports the pooled prevalence estimates of clinically elevated depression and anxiety among child and adolescents were 25.2% and 20.5%⁷, respectively. In our study, the mean of the WHO-5 index is 16.9 with SD 5.5. This number is slightly higher than that reported before the pandemic for young adults aged 18-39 years in Japan (mean 13.2 with SD 5.4)³⁹. The proportions of children who reported dissatisfaction with overall school experiences and friendship were 13.4% and 8.0%, respectively.

The cancellation status of school events is shown in Panel B of Table 1. In our study, 301 (16.7%) children experienced the cancellation of school excursions. Given the implementation rate of school excursions to be 76.1% in FY2021, as per an official statistics¹², the proportion of cancellations in our study sample seemed reasonable. The cancellation rate of school events excluding school excursions was 34.8% during FY2020–FY2022. Not surprisingly, the cancellation rate was the highest in 2020 (42.1%). However, the cancellation rate remained high at 38.6% in FY2021, when most developed countries had begun to substantially relax their COVID-19 policies. In FY2021, a state of emergency—sometimes called “mild lockdown”³⁶ to highlight the request-based nature of various Japanese non-pharmaceutical interventions—and a more moderate version of a mild lockdown (*Mannen boushi tou jyuuten sochi*, in Japanese) were in place for three quarters of the year in large cities such as Tokyo, and many schools had to cancel school events almost as much as in FY2020. The cancellation rate declined substantially in FY2022 though still being high (19.9%). The distribution of cancellation rates by fiscal year is shown in Figure 1. In Figure1-(a), a large variation in the total cancellation rate from FY2020 to FY2022 is shown. The cancellation status by event type (e.g., field trips, athletic meets, and festivals) has been summarized in SI Appendix, Table S11.

We now turn to the practice of “silent school lunch,” a poster child in the public debate on whether mitigation measures at school were too strict. In our data, the proportions of children who ate lunch silently without any conversation with their classmates were 95.7% and 88.4% in 2020 and 2021, respectively. It declined slightly thereafter, being 70.7% in March 2023.

Regarding other characteristics, 43.5% of children in our survey participated in extracurricular activities (“*Bukatsu*” in Japanese). The mean total score from subjective evaluation of the effectiveness of five major mitigation measures at school was 12.4 (interquartile range 9–15). Given that the total score is 15 if respondent answered “undecided” for all five mitigation measures at schools, the 75 percentile score (15) in our study sample indicated that several respondents believed that the effectiveness of their

school's mitigation measures was unclear. The distribution of this score is shown in SI Appendix, Figure SI2.

By grade levels, the proportion of students with depressive symptoms was 20.1% for high school students, 23.5% for junior high school students, and 13.9% for elementary school students. High school students had the highest rate of cancellations of school excursion (34.0%) and other school events (40.8%).

Table 1 Descriptive statistics

Panel A. Outcome		Total	3rd grade of high school	3rd grade of junior high school	6th grade of elementary school
WHO-5 index score below the clinical cutoff value	Yes	343 (19.1%)	113 (20.1%)	142 (23.5%)	88 (13.9%)
	No	1452 (80.9%)	448 (79.9%)	463 (76.5%)	541 (86.1%)
WHO-5 index score		Mean 16.9 (SD 5.5)	Mean 17.1 (SD 5.1)	Mean 16.5 (SD 5.5)	Mean 15.8 (SD 5.0)
Not satisfied: overall	Yes	240 (13.4%)	113 (20.1%)	83 (13.7%)	44 (7.0%)
	No	1555 (86.6%)	448 (79.8%)	522 (86.3%)	585 (93.0%)
Not satisfied: friendship	Yes	143 (8.0%)	59 (10.5%)	48 (7.9%)	36 (5.7%)
	No	1652 (92.0%)	502 (89.5%)	557 (92.0%)	593 (94.3%)
Very satisfied: overall	Yes	202 (11.3%)	54 (9.6%)	56 (9.3%)	92 (14.6%)
	No	1593 (88.7%)	507 (90.4%)	549 (90.7%)	537 (85.3%)
Very satisfied: friendship	Yes	307 (17.1%)	86 (15.3%)	106 (17.5%)	115 (18.3%)
	No	1488 (82.9%)	457 (84.7%)	499 (82.5%)	514 (81.7%)
Panel B. Characteristics					
School excursion	Cancelled	301 (16.7%)	191 (34.0%)	58 (9.6%)	52 (8.3%)
	Implemented	1494 (83.2%)	370 (65.9%)	547 (90.4%)	577 (91.7%)
Cancellation rate: 2020–2022		34.8%	40.8%	35.0%	29.2%
Cancellation rate in 2020		42.1%	46.8%	44.1%	38.3%
Cancellation rate in 2021		38.6%	46.5%	40.0%	36.4%
Cancellation rate in 2022		19.9%	26.3%	30.5%	27.7%
Silent lunch as of March 2023	Yes	1269 (70.7%)	378 (67.4%)	435 (71.9%)	456 (72.5%)
	No	526 (29.3%)	183 (32.6%)	170 (28.1%)	173 (27.5%)
Gender	Boy	912 (50.8%)	279 (49.7%)	315 (52.1%)	318 (50.6%)
	Girl	883 (49.2%)	282 (50.3%)	290 (47.9%)	311 (49.4%)
Evaluation score of mitigation measures in school		Mean: 12.4 (SD 5.9)	Mean: 11.9 (SD 5.8)	Mean: 12.7 (SD 6.0)	Mean: 12.6 (SD 5.8)
Extracurricular activities	Yes	780 (43.5%)	261 (46.5%)	242 (40.0%)	156 (24.0%)
	No	1015 (56.5%)	300 (53.5%)	363 (60.0%)	473 (76.0%)
Observations		1,795	561	605	629

Note: “SD” represents standard deviation

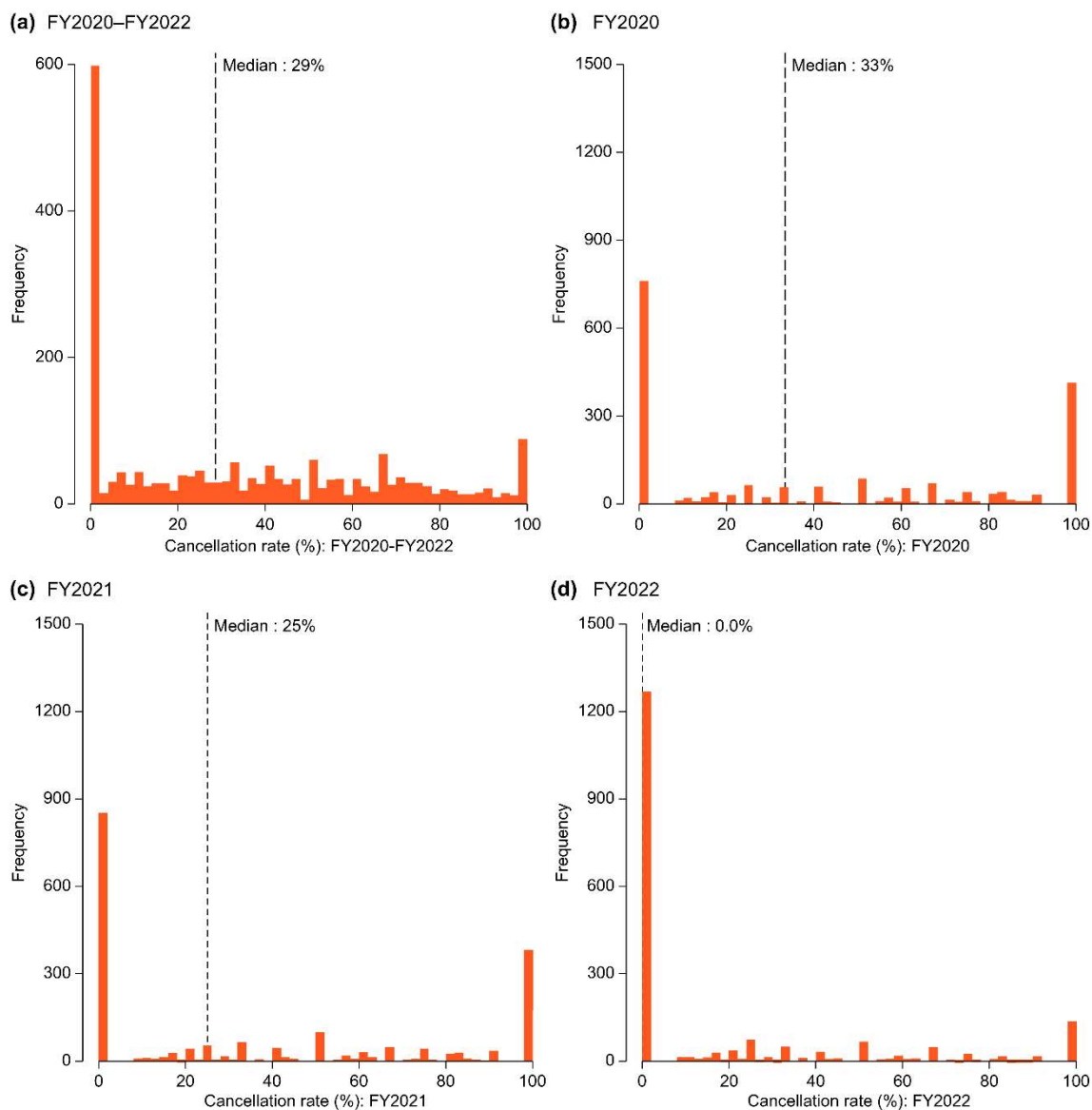


Figure 1. Distribution of the cancellation rate of school events by fiscal year.

Note: Cancellation rates were calculated from the cancellation status of 12 main school events excluding the cancellation of school excursions, namely (1) field trips, (2) social studies tours, (3) school events involving overnight stays other than school excursions, (4) athletic meets and festivals, (5) marathons, (6) swimming competitions, (7) ball game competitions (basketball, volleyball, dodgeball, etc.), (8) athletic events other than the above, (9) cultural and school art festivals, (10) chorus singing contests, (11) calligraphy contests, and (12) arts and humanities events other than the above. For each event, we excluded those that had not been held before 2020. For the cancellation rate of each event, see SI Appendix, Table SI2, $N = 1,795$.

3.2 Multivariate analysis

Results of the multivariate analysis of dissatisfaction and mental health are presented in Figure 2. Colors and symbols in this figure correspond to the outcome variables used in the analysis. First, we found the cancellation of school excursions to be associated with an increase in WHO-5 score (odds ratio [OR] 1.543 [95% confidence interval {CI} 1.109-2.148]), suggesting that the cancellation of school excursions induced the development of depressive symptoms among children. In addition, a high cancellation rate above the median was associated with dissatisfaction regarding the overall school experience (OR 1.650 [95% CI 1.222-2.228]) and friendship (OR 1.546 [95% CI 1.069-2.238]). While the association with WHO-5 score was not statistically significant, we found the point estimate of OR to exceed 1 (OR 1.221 [95% CI 0.948-1.571]). Silent school lunches were not associated with a tendency to report dissatisfaction or with depressive symptoms.

Importantly, children who were relatively skeptical about the effectiveness of mitigation measures at school were more likely to exhibit depressive symptoms (OR 1.423 [95% CI 1.113-1.820]). In other words, the extended implementation of school restrictions was particularly stressful when the children did not agree with the rationale. Participation in extracurricular activities is associated with lower risk of having depressive symptoms (OR, 0.679 [95% CI 0.522-0.882]).

In Figure 3, we report the outcome variables related to being “very satisfied” with the overall school experience and friendship. The cancellation of school excursions was associated with a lower probability of being very satisfied with friendship (OR 0.659 [95% CI 0.432-1.005]). The high cancellation of school events is significantly related to lower probability of being very satisfied with overall school experience (OR 0.470 [95% CI 0.340-0.649]) and friendship (OR 0.637 [95% CI 0.480-0.828]). While silent school lunches were not associated with dissatisfaction, they were associated with a reduction in the number of “very satisfied” responses. Participation in extracurricular activities increased the level of satisfaction with friendship to a large extent (OR 1.801 [95% CI 1.371-2.367]). This result was aligned with the fact that Japanese children tend to make close friends through such activities. Finally, we find no significant association between low evaluation of mitigation measures and various satisfaction outcomes in Figure 2 and 3.

Figure 4 summarizes the results of subsample analysis. First, cancellation of school excursions is associated with higher prevalence of depressive symptoms in girls (OR 1.871 [95% CI 1.153-3.037]) and in children who did not participate in extracurricular activities (OR 2.440 [95% CI 1.611-3.696]), as shown in Figure 4-(a).

Regarding the high cancellation rate of school events, we did not find large heterogeneity by subsample; however, the high cancellation rate was significantly associated with depressive symptoms among boys and children who participated in extracurricular activities. In addition, we found a relatively strong negative association between silent school lunches and depressive symptoms among elementary school children. Consistent with the full sample results on depressive symptoms in Figure 2, the low evaluation on mitigation measures in school was associated with depressive symptoms in boys (OR 1.519 [95% CI 1.061-2.175]), students without extracurricular activities (OR 1.438 [95% CI 1.035-1.998]), and junior high school students (OR 1.918 [95% CI 1.270-2.897]), though we could not find clear heterogeneity on this association due to low statistical power.

As shown in Figure 4-(b), a high cancellation rate is associated with low satisfaction with the overall school experience, except for junior high school students. In most subsample results, cancellation of school excursions and silent school lunches were negatively associated with satisfaction level; however, the estimated OR was noisy, since the sample size was smaller in subsample analysis.

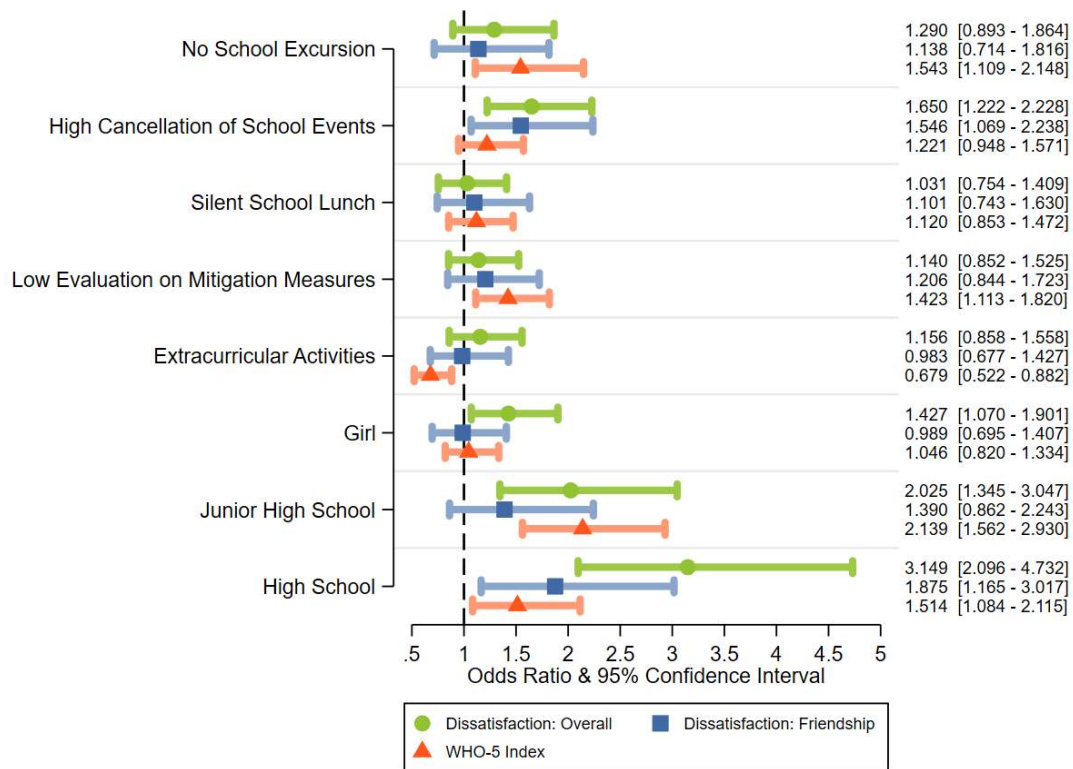


Figure 2. Factors associated with dissatisfaction and depressive symptoms.

Note: Results of logistic regression for the three outcome variables are shown. Outcome variable marked with a circle is a binary variable that takes a value of 1 if respondents are “very dissatisfied” or “dissatisfied” with overall school experience. Outcome variable marked with a square is a binary variable that takes a value of 1 if respondents are “very dissatisfied” or “dissatisfied” with friendship. The outcome variable marked with a square is a binary variable based on the WHO-5 index threshold criteria. Prefecture fixed effects are controlled for in all regressions. The marker represents the odds ratios while the range represents 95% confidence intervals. The values of odds ratios and 95% confidence intervals are presented on the right-hand side of the figure. N = 1,795. All the estimation results are shown in the SI Appendix, Table SI2.

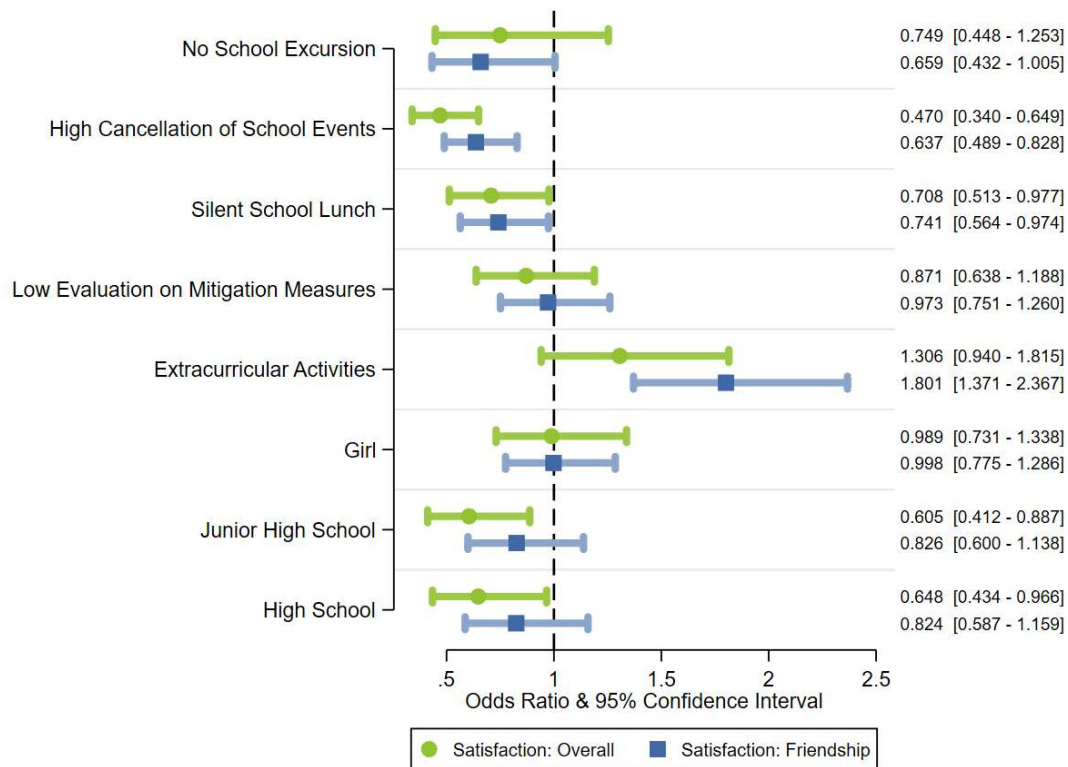
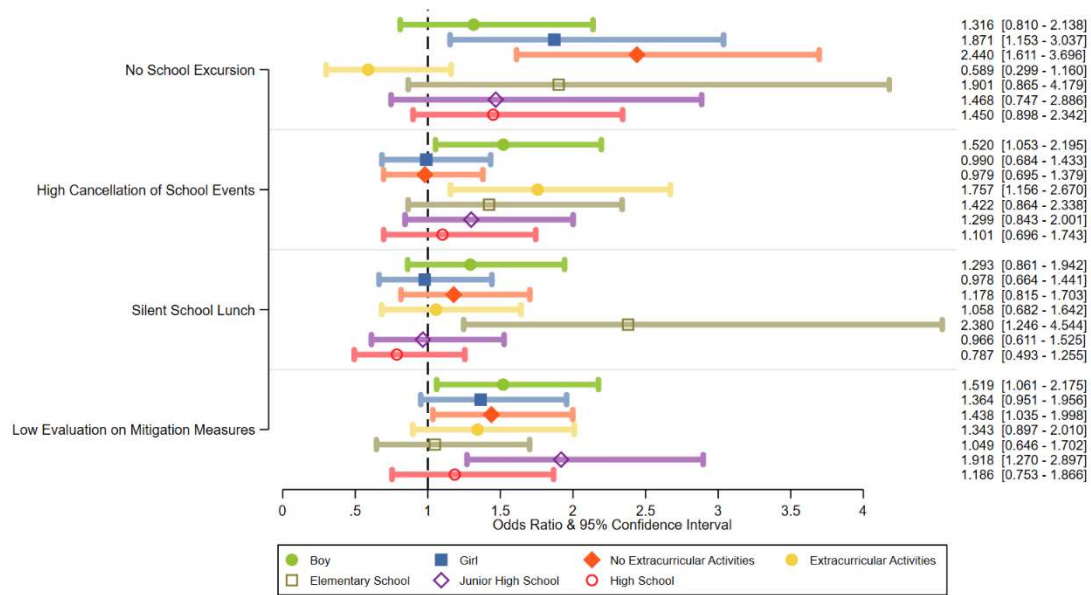


Figure 3. Factors associated with satisfaction with school experience and friendship.

Note: Results of logistic regression for the two outcome variables are shown. Outcome variable in the circle marker is a binary variable that takes a value of 1 if respondents are “very satisfied” with overall school experience. Outcome variable in the square marker is a binary variable that takes a value of 1 if respondents are “very satisfied” with friendship. The outcome variable in the square marker is a binary variable based on the WHO-5 index threshold criteria. Prefecture fixed effects are controlled for in all regressions. The marker represents the odds ratios and the range represents 95% confidence intervals. The values of odds ratios and 95% confidence intervals are presented on the right-hand side in this figure. N = 1,795. The estimation results are shown in the SI Appendix, Table SI2.

(a) Depressive symptoms (WHO-5 index)



(b) Satisfaction with school experience

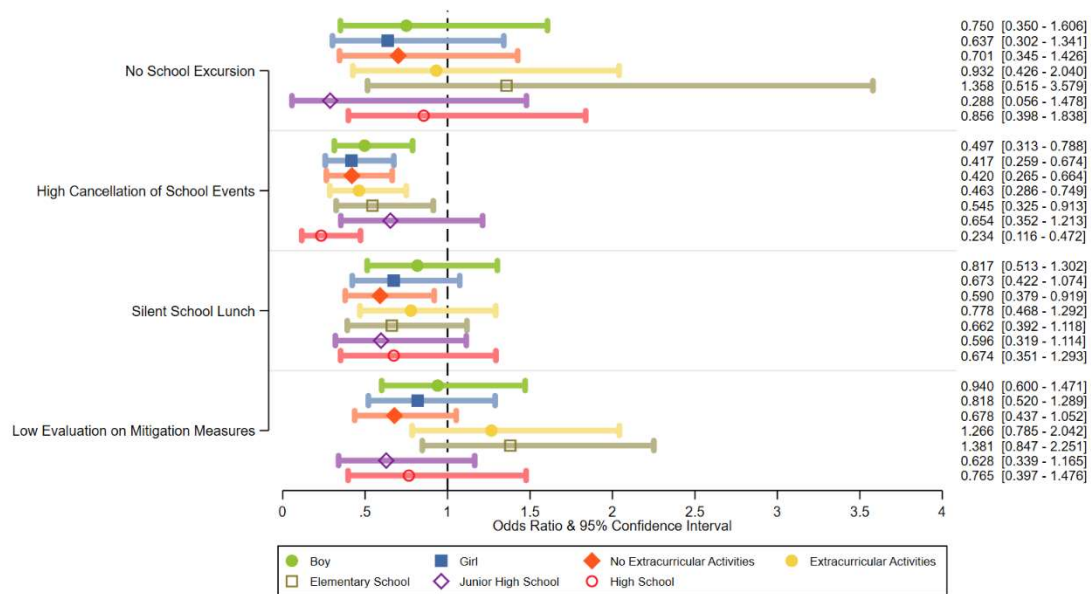


Figure 4. Subsample analysis on depressive symptoms (a) and satisfaction with school experience (b)

Note: In Figure (a), the outcome variable is binary based on the WHO-5 index threshold criteria. In Figure (b), the outcome variable is a binary variable that takes a value of 1 if respondents are “very satisfied” with overall school experience. Each marker represents a subsample category. “Bukatsu” and “No Bukatsu” represent children who participated and did not participate in extracurricular activities in school,

respectively. Prefecture fixed effects are controlled for in all regressions. The marker represents the odds ratios and the range represents the 95% confidence intervals. The values of odds ratios and 95% confidence intervals are presented on the right-hand side in this figure. The number of observations was 912 for “Boy,” 883 for “Girl,” 1015 for “No Bukatsu,” 780 for “Bukatsu,” 629 for “Elementary School,” 605 for “Junior High School,” and 561 for “High School.”

4. Discussion

Our study explored the effects of persistent mitigation measures in school on children’s mental health and psychological well-being. Unlike in other countries, children in Japan lived with strict mitigation measures at school for a long time, even though the schools reopened in May or June 2020. 16.7 percent of the children experienced cancellation of school excursions—events that are generally regarded as special—in 2020 and 2021. As of March 2023, 71% of the respondents in our survey ate lunch silently in schools. The mask mandate in schools was lifted off for the first time on April 1, 2023.

While many have studied the effects of school closures, during the initial waves of the COVID-19 pandemic, on the mental health of children, there have been a limited number of studies on the impact of persistent mitigation measures in schools. Mental health problems in childhood and adolescence cannot only worsen their current well-being but also have long-term adverse health and social consequences^{40–42}. Accordingly, the mental health effects of these long-lasting restrictions must be a key consideration when setting mitigation measures in schools.

With this goal in mind, we found that the cancellation of school excursions was associated with a higher risk of developing depressive symptoms in children. A high cancellation rate of school events was positively associated with the tendency to report dissatisfaction with schools and friendship, and negatively associated with the tendency to report high satisfaction with school experiences. The results indicated that long-term restrictive school experiences disrupt children’s mental health and psychological well-being.

In addition to the overall negative effect of cancellation of school events, we uncovered heterogeneous effects according to the characteristics of children. First, we found that girls and children with no extracurricular activities tended to exhibit depressive symptoms due to the cancellation of school excursions. The result seemed to be justified, since psychological provisions, such as intimacy and support, are priorities in girls’ friendship⁴³, and children who do not participate in extracurricular activities tend to have fewer opportunities to develop friendship with others. Emotional care of these children

would especially be important if a future pandemic forces the mass cancellation of school events again. Second, we found positive, significant association between the cancellation rate of school events and depressive symptom among boys and among those participated in extracurricular activities. If boys are more enthused by sports events at school than girls, the frequent cancellation of these events may affect the mental health of boys more strongly than that of girls. If school events serve as a venue for students to demonstrate their talents nurtured through extracurricular activities to friends, the cancellation of school events may affect the mental health of those who engage in extracurricular activities more strongly than those who do not.

We further found that children who were skeptical about the effectiveness of infection control measures in schools were more likely to develop depressive symptoms (OR 1.420 [95% CI 1.111-1.814]). This tendency was more pronounced in boys, children who did not participate in extracurricular activities, and junior high school students. The results suggested the importance of carefully explaining the rationale of strict mitigation measures to children and flexibly adjusting the measures as the knowledge of their effectiveness gets updated.

Finally, the effects of no school excursions and low evaluation of mitigation measures are different according to the outcome variables. First, no school excursions are statistically significantly associated with depressive symptoms, but only moderately with satisfaction measures (for example, OR 1.543 [95% CI 1.109-2.148] for WHO-5 index versus OR 0.659 [95% CI 0.432-1.005] for friendship satisfaction). This moderate association may arise if satisfaction is influenced by the comparison with peer groups. For example, students may feel more dissatisfied with the cancellation of a school excursion if neighboring schools go ahead with the excursion, but they may feel more satisfied if other schools also cancel, as they are more likely to think that the cancellation is inevitable. Second, low evaluation of mitigation measures is statistically significantly associated with depressive symptoms, but not with several satisfaction measures (for example, OR 1.423 [95% CI 1.113-1.820] for WHO-5 index versus OR 1.140 [95% CI 0.852-1.525] for dissatisfaction with overall school experience). This lack of association may reflect the possibility that students may see strict mitigation measures as inevitable when neighboring schools also implement them, even if these measures are detrimental to their mental health.

Since our study was based on a cross-sectional framework, several cautions are needed when we interpret the results. Among those, we explicitly discuss two major aspects. First, the estimated effects of mitigation measures may be confounded by the effects of other concurrent policies on COVID-19. For example, school events might have

been cancelled more frequently in areas with high infection, and children in such areas might have experienced longer school closures than others. While this confounding effect is a concern, it is unlikely to be large after controlling for prefecture-fixed effects, since the prefectural governors in charge have the right to request schools to close, and the duration of school closures is mainly determined at the prefectural level. When we compared the results with and without prefecture-fixed effects in SI Appendix, Figure SI3, they were almost identical.

A closer look at the regional variation in the cancellation of school events further supported the idea that mitigation measures in schools are subject to local idiosyncratic factors and that the confounding bias is unlikely to be large. In SI Appendix, Figure SI4, the implementation rate of school excursions in public high schools in 2020 and 2021 is shown based on the official statistics on school events⁴⁴. The figure shows that prefectures with similar epidemic statuses, such as Tokyo and Osaka, can have significantly different implementation rates. Public high schools in Tokyo cancelled nearly all school excursions in 2020 and 2021, whereas the implementation rates in Osaka were 52% in 2020 and 100% in 2021. Some rural prefectures, such as Shimane, exhibited very low implementation rates, whereas others, such as Oita and Kagoshima, exhibited high implementation rates. Anecdotal evidence suggested that the strictness of mitigation measures significantly depends on the characteristics of the governor-in-charge. The large disparities in the cancellation or implementation status within relatively homogenous prefectures suggested that the cancellation or implementation of school events was subject to idiosyncratic local factors, indicating that the simple regression analysis in this study could possibly be sufficient to uncover the causal effects of the cancellation of school events.

Second, in this study, we relied on the binary decision regarding whether each school event was held or not, ignoring the manner in which it was held, if at all. For example, even if a school excursion was held, it might have been scaled down to a large extent (such as, location of the school trip may have been changed from overseas to a nearby city). Sports days in many schools were often held without family audience, even if they were held. Therefore, we are, in part, comparing children who experienced the cancellation of a school event with those who experienced the event even if in a restricted manner, as opposed to those who experienced the event without any restriction. Since the occurrence of restricted execution of school events was prevalent, our study underestimated the negative impact of school event cancellation during the COVID-19 pandemic.

Third, as discussed early, we asked the parents to complete the survey with their

children. It is possible that children hide their true feelings and thoughts from their parents. Because we cannot determine the direction of bias associated with this feature of our survey, it would be useful to supplement this study with another qualitative, face-to-face survey in future research.

Despite the limitations, our study has several strengths. To the best of our knowledge, our study was the first to shed light on the cumulative effects of long-term school restrictions on children's mental health and psychological well-being. Since previous studies generally focused on the effects of school closures^{3,5,19–22} rather than the potential negative effects associated with long-lasting restrictions at re-opened schools, the current study fills an important gap in the literature. In addition, we implemented the survey in a timely manner, in March 2023, when students in Japan graduate from their respective schools (sessions in Japanese schools start in April and end in March), and hence, the respondents were children in the final year of their schools. Had the survey been conducted later, it might have suffered from a more severe recall bias and memory fading, since the respondents would have already moved into a different stage of life. Had the survey been conducted earlier, it might have underestimated the cumulative effects of the three-year-long school restrictions.

From the perspective of policy implications, other mitigation measures could have implemented better balance of infection control and children's well-being in school. For example, a greater promotion of hand sanitization^{45,46} and more frequent PCR testing at schools⁴⁷ might have been able to mitigate the spread of infection without generating the mass cancellation of school events and disrupting friendship among children, which some psychological studies claim is a concern in terms of emotional recognition^{15,48–50} and cognitive performance⁵¹.

Finally, we would like to note that children's well-being should be a key factor in determining the degree of mitigation measures in school. The WHO Constitution stipulates that mitigation measures should be implemented in a manner that respects individual liberties and always considers the least burdensome methods for children⁴⁶. The UN Convention on the Rights of the Child requires that in all actions concerning children, whether undertaken by public or private social welfare institutions, courts of law, administrative authorities, or legislative bodies, the best interests of the child should be a primary consideration (Article 3). It would be important to strike a balance between protecting children and their parents from COVID-19, and protecting children from the potential harm associated with strict mitigation measures. The potential harm we highlighted in this paper—deterioration in mental health—has not received much attention till date in the policy debate on the pandemic response in Japan. Lack of

attention to this issue was particularly concerning in 2022 and 2023, after vaccination became widespread and the case fatality rate dropped dramatically even among the adult population; moreover, several systematic reviews till date have shown that children and schools might play only a limited role in COVID-19 transmission^{45,46}. Looking forward, it is desirable for the Japanese society to discuss ways to smoothly guide children to return to their pre-pandemic lifestyle. In future pandemics, it will be important to carefully examine the ethical issues and effectiveness of schools' mitigation measures from an interdisciplinary perspective.

For future studies, it would be interesting to explore how mental health disruption in children during the pandemic will have persistent effects on their later life. Although several studies have already shown that a negative experience and deteriorated mental health during childhood causes long-term adverse health and social consequences⁴⁰⁻⁴² in normal times, researchers have only just begun to explore the medium- and long-term impacts of mitigation measures during a pandemic. The accumulation of such studies will contribute significantly to the development of research on how childhood experiences are linked to outcomes in adulthood.

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Supplementary Information (SI) Appendix

Figure SI 1. School chorus with mask (a), and school lunch in silence (*Mokusyoku*) (b).

(a)



(b)



Sources:

(a) Saitama News Paper, November 30, 2020. URL: <https://www.saitama-np.co.jp/articles/6639/postDetail>.

(b) Shichimatsu elementary school in Amagasaki city, Hyogo, September 2, 2021. URL: <http://www.ama-net.ed.jp/school/e31/2021/09/post-687.html>.

Figure SI 2. Distribution of the total score from the subjective evaluation of infection control measures in school.

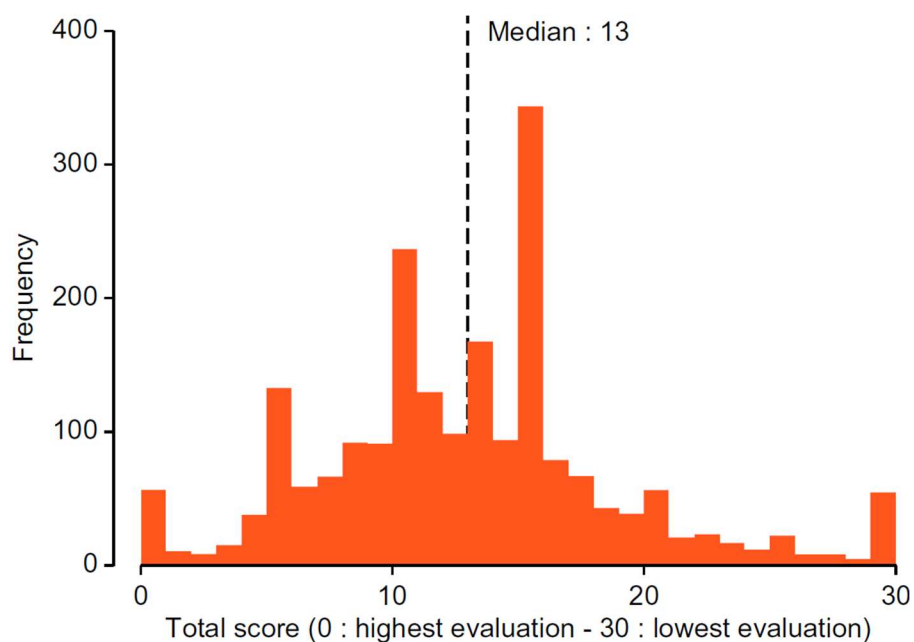
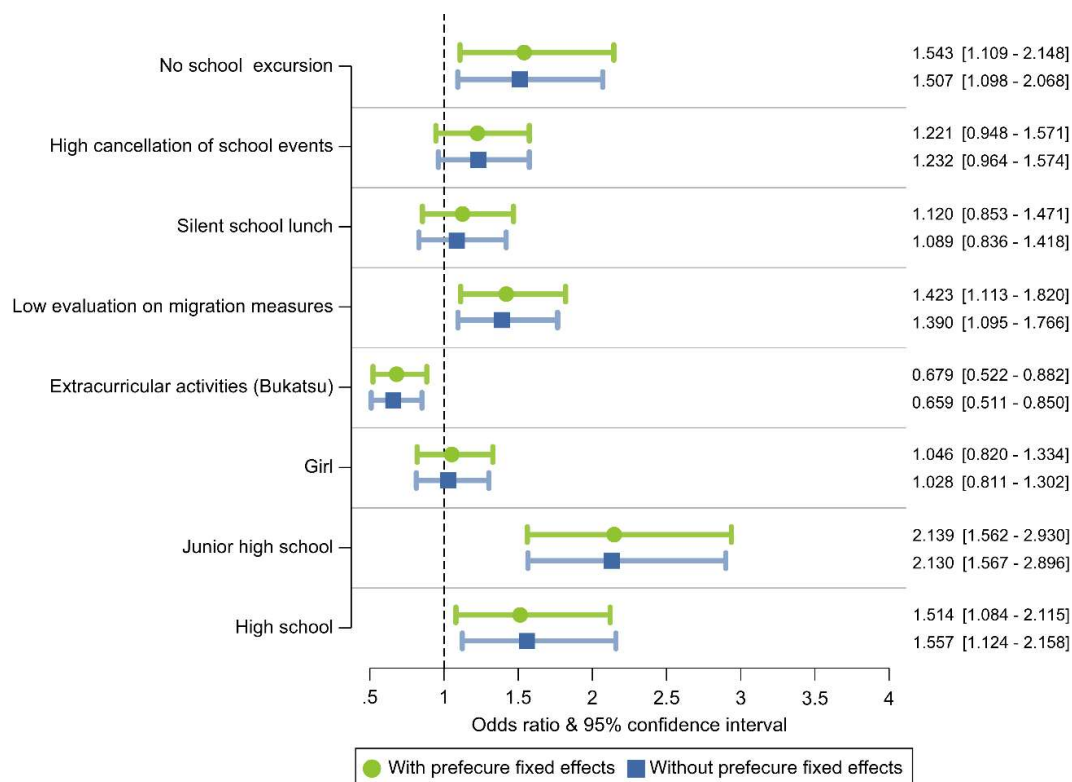
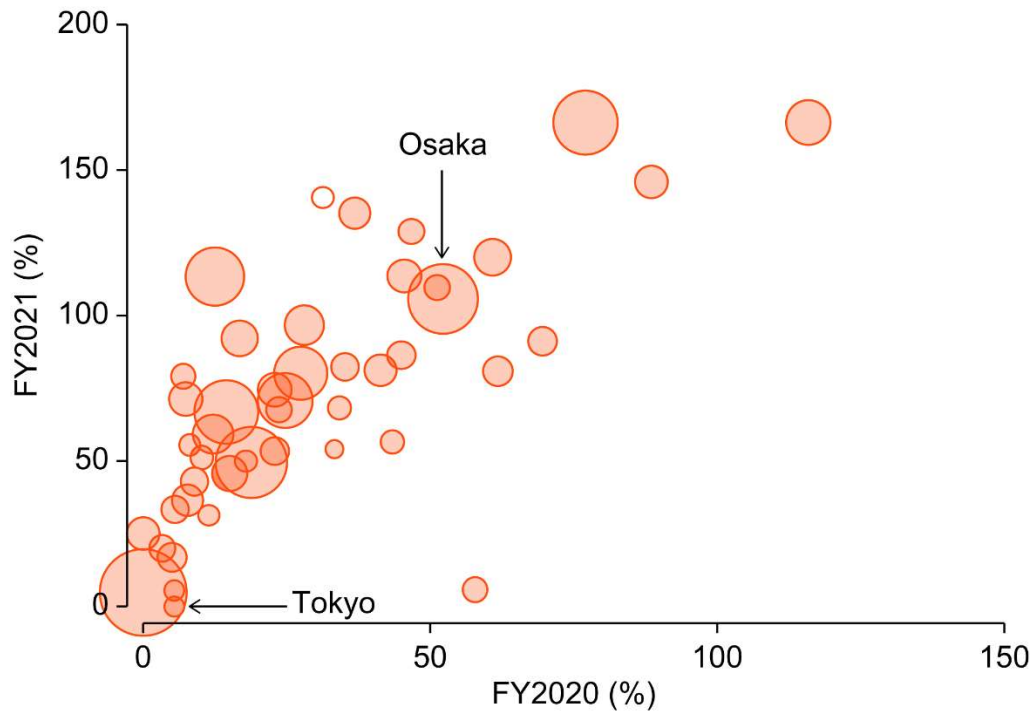


Figure SI 3. Results on WHO-5 index with and without prefecture-fixed effects.



Note: The outcome variable is a binary variable based on the WHO-5 index threshold criteria. The marker represents the odds ratios while the range represents 95% confidence intervals. The values of odds ratios and 95% confidence intervals are presented on the right-hand side of the figure. N = 1,795.

Figure SI 4: Proportion of public high schools that conducted school excursion by prefecture.



Note: Size of the bubbles corresponds to the population. The proportion can exceed 100%, because some high schools implemented school excursion for multiple grades. For example, some schools did not offer a school excursion for second-year high school students in 2020 but offered it jointly for third- and second-year high school students in 2021.

Source: National Association for the Study and Research of School Excursion (2022)

Table SI 1. Details on the cancellation status of school events by fiscal years

	Year	Number that would normally have been implemented (a)	Number of cancellation (b)	Cancellation rate (b/a)
Field trip	2020	1574	742	47.1%
	2021	1504	585	38.9%
	2022	1380	260	18.8%
Social studies field trip	2020	1474	746	50.6%
	2021	1375	609	44.3%
	2022	1274	315	24.7%
School events involving overnight stays other than school excursions	2020	1163	668	57.4%
	2021	1230	633	51.5%
	2022	874	320	36.6%
Athletic meets and festivals	2020	1933	563	29.1%
	2021	1874	494	26.4%
	2022	1884	209	11.1%
Marathons	2020	1070	523	48.9%
	2021	1041	494	47.5%
	2022	1005	311	30.9%
Swimming competitions	2020	682	410	60.1%
	2021	675	425	63.0%
	2022	642	299	46.6%
Ball games (basketball, volleyball, dodgeball, etc.)	2020	1114	492	44.2%
	2021	1095	485	44.3%
	2022	1087	252	23.2%
Athletic events other than athletic meets and sports festivals other than those listed above	2020	870	446	51.3%
	2021	799	442	55.3%
	2022	763	280	36.7%
Cultural festivals and school arts festivals	2020	1506	585	38.8%
	2021	1429	534	37.4%
	2022	1427	238	16.7%
Chorus contests	2020	1130	542	48.0%
	2021	1068	506	47.4%
	2022	1054	268	25.4%
Calligraphy contests	2020	665	295	44.4%
	2021	669	329	49.2%
	2022	633	222	35.1%
Humanities-related events other than those listed above	2020	635	350	55.1%
	2021	639	372	58.2%
	2022	611	253	41.4%

Table SI 2. Details of the logistic regression results on mental health and (dis)satisfaction

	Dissatisfaction Overall (1)	Dissatisfaction Friendship (2)	WHO-5 (3)	Satisfaction Overall (4)	Satisfaction Friendship (5)
No school excursion	1.29 (0.893 - 1.864)	1.138 (0.714 - 1.816)	1.543** (1.109 - 2.148)	0.749 (0.448 - 1.253)	0.659* (0.432 - 1.005)
High cancellation of school events	1.650*** (1.222 - 2.228)	1.546** (1.069 - 2.238)	1.221 (0.948 - 1.571)	0.470*** (0.340 - 0.649)	0.637*** (0.489 - 0.828)
Silent school lunch	1.031 (0.754 - 1.409)	1.101 (0.743 - 1.630)	1.12 (0.853 - 1.472)	0.708** (0.513 - 0.977)	0.741** (0.564 - 0.974)
Low evaluation of mitigation measures	1.14 (0.852 - 1.525)	1.206 (0.844 - 1.723)	1.423*** (1.113 - 1.820)	0.871 (0.638 - 1.188)	0.973 (0.751 - 1.260)
Extracurricular activities (<i>Bukatsu</i>)	1.156 (0.858 - 1.558)	0.983 (0.677 - 1.427)	0.679*** (0.522 - 0.882)	1.306 (0.940 - 1.815)	1.801*** (1.371 - 2.367)
Girl	1.427** (1.070 - 1.901)	0.989 (0.695 - 1.407)	1.046 (0.820 - 1.334)	0.989 (0.731 - 1.338)	0.998 (0.775 - 1.286)
Junior high school	2.025*** (1.345 - 3.047)	1.39 (0.862 - 2.243)	2.139*** (1.562 - 2.930)	0.605** (0.412 - 0.887)	0.826 (0.600 - 1.138)
High school	3.149*** (2.096 - 4.732)	1.875*** (1.165 - 3.017)	1.514** (1.084 - 2.115)	0.648** (0.434 - 0.966)	0.824 (0.587 - 1.159)
Constant	0.029*** (0.012 - 0.071)	0.048*** (0.018 - 0.124)	0.159*** (0.084 - 0.301)	0.178*** (0.071 - 0.447)	0.226*** (0.111 - 0.462)
Prefecture Fixed Effects	yes	yes	yes	yes	yes
Observations	1795	1795	1795	1795	1795

Note: 95% confidence intervals in parentheses. Prefecture-fixed effects are controlled for. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$